

PATENT

Atty. Dkt. No. APPM/006716.Y1/ETCH/SILICON/MD-DAO

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REMARKS

The Applicant requests that the Examiner enter the amendment prior to examining the application.

Claims 1, 3-4, 6-18, 20-21, 23-33, and 50-61 remain pending in the application upon entry of this response. Claims 1, 3-4, 6-18, 20-21, and 23-33 stand rejected by the Examiner. Claims 50-61 have been added. Please reconsider the claims for the reasons presented below.

Claims 1 and 18 have been amended to clarify implicit aspects of the invention. Claims 3, 4, 6, 7, 23 are amended correct formalities. Entry of these amendments and reconsideration of the claims is respectfully requested.

Claims 1, 3-4, 6-7, 17-18, 20 and 23-24

Claims 1, 3-4, 6-7, 17-18, 20 and 23-24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Toprac* (U.S. Patent No. 6,379,980) in view of *Payne* (U.S. Patent No. 5,329,381), as evidenced by *Wilby* (U.S. Publ. No. 2003/0141572). Applicant respectfully responds.

The combination of *Toprac*, *Payne*, and *Wilby* does not teach, show, or suggest all the claim limitations of claims 1 and 18. *Toprac* teaches measuring the thickness of a process layer, removing at least a portion of the process layer until an end point of the removal process is reached, determining a removal rate based on the measured thickness, and comparing the removal rate to an expected removal rate. The Examiner acknowledges that *Toprac* does not disclose applying an outlier filter to remove outliers in the pre-etch measurement information, but relies on *Payne* to disclose an outlier filter. *Payne* discloses an outlier noise filter that removes noisy pixels from a digital image. The outlier filter of *Payne* inspects individual pixels in relation to other neighboring pixels, and does not evaluate the quality of a digital image.

The combination of *Toprac*, *Payne*, and *Wilby* does not teach, show, or suggest a method for monitoring an etch process, comprising performing pre-etch measurements of a substrate to generate pre-etch measurement information, applying

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an outlier filter to remove outliers in the pre-etch measurement information, analyzing the pre-etch measurement information to determine that a patterning is of a sufficient quality to allow for etching of the substrate, providing the substrate along with the pre-etch measurement information to an etch reactor, etching the substrate in the etch reactor using an etch process, wherein the pre-etch measurement information in combination with etch process monitoring are used to monitor an etch process endpoint, and terminating the etch process based on the etch process monitoring having identified that the etch process has reached the etch process endpoint, as recited in claim 1 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Furthermore, the combination of *Toprac*, *Payne*, and *Wilby* does not teach, show, or suggest a method for monitoring an endpoint of a mask trimming process, comprising performing pre-etch measurements of a substrate having a mask thereon to generate pre-etch measurement information of such mask, applying an outlier filter to remove outliers in the pre-etch measurement information, analyzing the pre-etch measurement information to determine that the mask is of a sufficient quality to allow for etching of the substrate, providing the substrate along with the pre-etch measurement information to an etch reactor, trimming the mask using an etch process, wherein the pre-etch measurement information in combination with etch process monitoring are used to monitor the trimming the mask, and terminating the trim process when the etch process monitoring indicates that the mask has been trimmed to pre-determined dimensions, as recited in claim 18 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 1, 3-4, 6-9, 11-13, 15, 17-18, 20, 23-26, 28-30 and 32

Claims 1, 3-4, 6-9, 11-13, 15, 17-18, 20, 23-26, 28-30 and 32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Klippert II et al* (U.S. Patent No. 6,136,712) in view of *John H. Payne* (U.S. Patent No. 5,329,381). Applicant respectfully responds.

The combination of *Klippert II* and *Payne* does not teach, show, or suggest all the claim limitations of claims 1 and 18. *Klippert II* teaches an automated process which measures the thickness of a masking layer prior to etching. The masking layer thickness

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and real-time measurements control when etching is terminated. The Examiner acknowledges that *Klippert II* does not disclose applying an outlier filter to remove outliers in the pre-etch measurement information, but relies on *Payne* to disclose an outlier filter. *Payne* discloses an outlier noise filter that removes noisy pixels from a digital image. The outlier filter of *Payne* inspects individual pixels in relation to other neighboring pixels, and does not evaluate the quality of a digital image.

The combination of *Klippert II* and *Payne* does not teach, show, or suggest a method for monitoring an etch process, comprising performing pre-etch measurements of a substrate to generate pre-etch measurement information, applying an outlier filter to remove outliers in the pre-etch measurement information, analyzing the pre-etch measurement information to determine that a patterning is of a sufficient quality to allow for etching of the substrate, providing the substrate along with the pre-etch measurement information to an etch reactor, etching the substrate in the etch reactor using an etch process, wherein the pre-etch measurement information in combination with etch process monitoring are used to monitor an etch process endpoint, and terminating the etch process based on the etch process monitoring having identified that the etch process has reached the etch process endpoint, as recited in claim 1 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Furthermore, the combination of *Klippert II* and *Payne* does not teach, show, or suggest a method for monitoring an endpoint of a mask trimming process, comprising performing pre-etch measurements of a substrate having a mask thereon to generate pre-etch measurement information of such mask, applying an outlier filter to remove outliers in the pre-etch measurement information, analyzing the pre-etch measurement information to determine that the mask is of a sufficient quality to allow for etching of the substrate, providing the substrate along with the pre-etch measurement information to an etch reactor, trimming the mask using an etch process, wherein the pre-etch measurement information in combination with etch process monitoring are used to monitor the trimming the mask, and terminating the trim process when the etch process monitoring indicates that the mask has been trimmed to pre-determined dimensions, as recited in claim 18 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

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Claims 1, 3-4, 6-9, 11-13, 15, 17-18, 20, 23-26, 28-30 and 32

Claims 1, 3-4, 6-9, 11-13, 15, 17-18, 20, 23-26, 28-30 and 32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Petrucci et al* (WO 01/24254) in view of *John H. Payne* (U.S. Patent No. 5,329,381). Applicant respectfully responds.

The combination of *Petrucci* and *Payne* does not teach, show, or suggest all the claim limitations of claims 1 and 18. *Petrucci* teaches an etch method which includes the steps of measuring a thickness of a mask layer on top of a substrate, measuring the depth of a recess during an etching step, and stopping the etching step when the depth value reaches a sum of the target depth value and the thickness value. The Examiner acknowledges that *Petrucci* does not disclose applying an outlier filter to remove outliers in the pre-etch measurement information, but relies on *Payne* to disclose an outlier filter. *Payne* discloses an outlier noise filter that removes noisy pixels from a digital image. The outlier filter of *Payne* inspects individual pixels in relation to other neighboring pixels, and does not evaluate the quality of a digital image.

The combination of *Petrucci* and *Payne* does not teach, show, or suggest a method for monitoring an endpoint of a mask trimming process, comprising performing pre-etch measurements of a substrate having a mask thereon to generate pre-etch measurement information of such mask, applying an outlier filter to remove outliers in the pre-etch measurement information, analyzing the pre-etch measurement information to determine that the mask is of a sufficient quality to allow for etching of the substrate, providing the substrate along with the pre-etch measurement information to an etch reactor, trimming the mask using an etch process, wherein the pre-etch measurement information in combination with etch process monitoring are used to monitor the trimming the mask, and terminating the trim process when the etch process monitoring indicates that the mask has been trimmed to pre-determined dimensions, as recited in claim 1 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Furthermore, the combination of *Petrucci* and *Payne* does not teach, show, or suggest a method for monitoring an endpoint of a mask trimming process, comprising performing pre-etch measurements of a substrate having a mask thereon to generate

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pre-etch measurement information of such mask, applying an outlier filter to remove outliers in the pre-etch measurement information, analyzing the pre-etch measurement information to determine that the mask is of a sufficient quality to allow for etching of the substrate, providing the substrate along with the pre-etch measurement information to an etch reactor, trimming the mask using an etch process, wherein the pre-etch measurement information in combination with etch process monitoring are used to monitor the trimming the mask, and terminating the trim process when the etch process monitoring indicates that the mask has been trimmed to pre-determined dimensions, as recited in claim 18 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 1, 3-4, 6-9, 11-13, 15, 17-18, 20, 23-26, 28-30 and 32

Claims 1, 3-4, 6-9, 11-13, 15, 17-18, 20, 23-26, 28-30 and 32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Grimbergen et al* (U.S. Patent No. 6,390,019) in view of *John H. Payne* (U.S. Patent No. 5,329,381). Applicant respectfully responds.

The combination of *Grimbergen* and *Payne* does not teach, show, or suggest all the claim limitations of claims 1 and 18. *Grimbergen* teaches measuring the thickness of the layer to be etched on a substrate, transferring the substrate from a load-lock transfer chamber by a robot arm through a slit valve and into a process chamber, using the layer thickness to estimate operating conditions, monitoring the process by a process monitoring system to change conditions or to stop the etching process. The Examiner acknowledges that *Grimbergen* does not disclose applying an outlier filter to remove outliers in the pre-etch measurement information, but relies on *Payne* to disclose an outlier filter. *Payne* discloses an outlier noise filter that removes noisy pixels from a digital image. The outlier filter of *Payne* inspects individual pixels in relation to other neighboring pixels, and does not evaluate the quality of a digital image.

The combination of *Grimbergen* and *Payne* does not teach, show, or suggest a method for monitoring an endpoint of a mask trimming process, comprising performing pre-etch measurements of a substrate having a mask thereon to generate pre-etch measurement information of such mask, applying an outlier filter to remove outliers in

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the pre-etch measurement information, analyzing the pre-etch measurement information to determine that the mask is of a sufficient quality to allow for etching of the substrate, providing the substrate along with the pre-etch measurement information to an etch reactor, trimming the mask using an etch process, wherein the pre-etch measurement information in combination with etch process monitoring are used to monitor the trimming the mask, and terminating the trim process when the etch process monitoring indicates that the mask has been trimmed to pre-determined dimensions, as recited in claim 1 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Furthermore, the combination of *Grimbergen* and *Payne* does not teach, show, or suggest a method for monitoring an endpoint of a mask trimming process, comprising performing pre-etch measurements of a substrate having a mask thereon to generate pre-etch measurement information of such mask, applying an outlier filter to remove outliers in the pre-etch measurement information, analyzing the pre-etch measurement information to determine that the mask is of a sufficient quality to allow for etching of the substrate, providing the substrate along with the pre-etch measurement information to an etch reactor, trimming the mask using an etch process, wherein the pre-etch measurement information in combination with etch process monitoring are used to monitor the trimming the mask, and terminating the trim process when the etch process monitoring indicates that the mask has been trimmed to pre-determined dimensions, as recited in claim 18 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 10, 20 and 27

Claims 10, 20 and 27 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Anthony J. Toprac* (U.S. 6,379,980) in view of *John H. Payne* (U.S. 5,329,381) as applied to claims 1, 3-4, 6-7, 17-18, 20 and 23-24 and further in view of *Bin Yu* (U.S. Patent No. 6,368,982). Applicant respectfully traverses the rejection.

The teachings of *Toprac* and *Payne* are described above. As described above, the combination of *Toprac* and *Payne* does not teach, show, or suggest all the claim limitations of claims 1 and 18. The examiner relies on *Yu* as teaching that during a mask

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trim the mask undergoes etching from all sides and leaves a scaled down length and that the two sides and the top are trimmed by substantially the same trim length. Thus, *Yu* does not cure the deficiency of the *Toprac* and *Payne* combination. Accordingly, Applicant respectfully requests that these rejections be withdrawn and the claims allowed.

Claims 14 and 31

Claims 14 and 31 stand rejected under 35 U.S.C. § 102(b) as being unpatentable over *Klippert II et al* (U.S. Patent No. 6,136,712) in view of *John H. Payne* (U.S. Patent No. 5,329,381) as applied to claims 1, 3-4, 6-9, 11-13, 15, 17-20, 23-26, 28-30 and 32 and further in view of *Nakada et al* (JP 11-251252). Applicant respectfully traverses the rejection.

The teachings of *Klippert II* and *Payne* are described above. As described above, the combination of *Klippert II* and *Payne* does not teach, show, or suggest all the claim limitations of claims 1 and 18. The examiner relies on *Nakada* as teaching that light having a desired wavelength and modulation of intensity is used for monitoring a plasma. Thus, *Nakada* does not cure the deficiency of the *Klippert II* and *Payne* combination. Accordingly, Applicant respectfully requests that these rejections be withdrawn and the claims allowed.

Claims 16 and 33

Claims 16 and 33 stand rejected under 35 U.S.C. § 102(b) as being unpatentable over *Grimbergen et al* (U.S. 6,390,019) in view of *John H. Payne* (U.S. Patent No. 5,329,381) as applied to claims 1, 3-4, 6-9, 11-13, 15, 17-20, 23-26, 28-30 and 32 and further in view of *Grimbergen et al* (U.S. Patent No. 6,406,924, hereinafter *Grimbergen II*). Applicant respectfully traverses the rejection.

The teachings of *Grimbergen* and *Payne* are described above. As described above, the combination of *Grimbergen* and *Payne* does not teach, show, or suggest all the claim limitations of claims 1 and 18. The examiner relies on *Grimbergen II* as teaching that as the structures are etched, the minimas and maxima of the interferometric signal shift because the position of minima and maxima are indicative of

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etch depth. Thus, *Grimbergen II* does not cure the deficiency of the *Grimbergen* and *Payne* combination. Furthermore, claims 16 and 33 recite a correlation between the spectral position of the minimum in the spectrum and a width of structures formed on the substrate, not etch depths as disclosed by *Grimbergen II*. Accordingly, Applicant respectfully requests that these rejections be withdrawn and the claims allowed.

Claim 21

Claim 21 stands rejected under 35 U.S.C. § 102(b) as being unpatentable over *Anthony J. Toprac* (U.S. Patent No. 6,379,980) in view of *John H. Payne* (U.S. Patent No. 5,329,381) as applied to claims 1, 3-4, 6-7, 17-18, 20 and 23-24 and further in view of *Cha et al* (U.S. Patent No. 6,319,767). Applicant respectfully traverses the rejection.

The teachings of *Toprac* and *Payne* are described above. As described above, the combination of *Toprac* and *Payne* does not teach, show, or suggest all the claim limitations of claims 1 and 18. The examiner relies on *Cha* as teaching that the photoresist mask is reduced by plasma. Thus, *Cha* does not cure the deficiency of the *Toprac* and *Payne* combination. Accordingly, Applicant respectfully requests that these rejections be withdrawn and the claims allowed.

New claims 50-61

Applicant has added new claims 50-61. The combination of *Grimbergen*, *Payne*, and *Grimbergen II* does not teach, show, or suggest the claim limitations of claim 50. *Grimbergen* teaches measuring the thickness of the layer to be etched on a substrate, transferring the substrate from a load-lock transfer chamber by a robot arm through a slit valve and into a process chamber, using the layer thickness to estimate operating conditions, monitoring the process by a process monitoring system to change conditions or to stop the etching process. The Examiner acknowledges that *Grimbergen* does not disclose applying an outlier filter to remove outliers in the pre-etch measurement information, but relies on *Payne* to disclose an outlier filter. Furthermore, the examiner relies on *Grimbergen II* as teaching that as the structures are etched, the minimas and maxima of the interferometric signal shift because the position of minima and maxima are indicative of etch depth. However, claim 50 (and claims 16 and 33) recite a

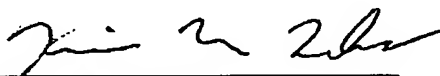
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correlation between the spectral position of the minimum in the spectrum and the width of structures formed on the substrate, not etch depths as disclosed by *Grimbergen II*. Accordingly, Applicant respectfully requests that claims 50-61 be allowed.

In conclusion, the references cited by the Examiner, alone or in combination, do not teach, show, or suggest the claimed invention. The Applicant respectfully submits that the claims are in condition for allowance and respectfully requests that the claims be allowed.

Respectfully submitted,



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